

GUI for Medical Images Filtering based on Discrete Wavelet Transformation

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Abstract – In the paper is presented a medical image filtering software and its graphic user interface (GUI). The software reduces the noise on the base of the discrete wavelet transformation (DWT). It works in the MATLAB environment and uses defined functions in WAVELET TOOLBOXES. Different noise types and models can be used, regarding to different medical modalities of the images. With the software can be made a nonlinear or adaptive filtration, by using global or penalized thresholds in three directions: horizontal, vertical and diagonally. The GUI proposes also an interactive option to choose the type of the wavelet function and the level for the decomposition.

The presented GUI is also suitable to engineering education for studying this wavelet application.

Some experimental results are presented, obtained by computer simulation in MATLAB Environment.

Keywords – Medical image filtering, wavelet discrete transformation, thresholds methods, graphic user interface, computer simulation.

I. INTRODUCTION

The medical imaging technologies exploit the interaction between the human anatomy and the output of emissive materials or emissions devices. These emissions are then used to obtain pictures of human anatomy. The most popular technologies are ultrasound (US), X-rays, Computed tomography (CT) and Magnetic resonance imaging (MRI). These images provide important anatomical information to physicians and specialist upon which can be made diagnoses [1]. The goals of medical image filtration include improvement of the visibility and perceptibility of the various regions and tasks such as cleaning the medical image from specific types of noise.

In medical image pre-processing can be used effective methods for reducing the noise components, based on DWT.

The paper presents an application and GUI for filtering of different medical modalities images. The noise reduction can be realized by using global or penalized thresholds. For determination of the threshold the Birge-Massart strategy is used [2]. This strategy is flexible and determines the threshold in three directions: horizontal, vertical and diagonally. In addition the threshold can be hard or soft [3]. The software is created in MATLAB 6.5 environment by using WAVELET TOOLBOX and IMAGE PROCESSING TOOLBOX.

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The graphic user interface consists of checkboxes, buttons, edit boxes, pop-up controls, which make it easy to use. Users enter or choose input data in a single form, because input information changes and visualizations are easier and faster in this way.

The applied algorithm calculates also some objective quantitative estimation parameters as: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR) [4]. On the base of their analysis can be selected the most suitable wavelet function, level of decomposition, type of the threshold and its parameters [5]. It determines more precise noise reduction of the different medical modalities images.

II. THE GUI FOR MEDICAL IMAGES FILTERING

The Fig.1 shows the GUI for medical images filtering. It is divided in several areas, where the user applies different settings, concerning noise and discrete wavelet transform.

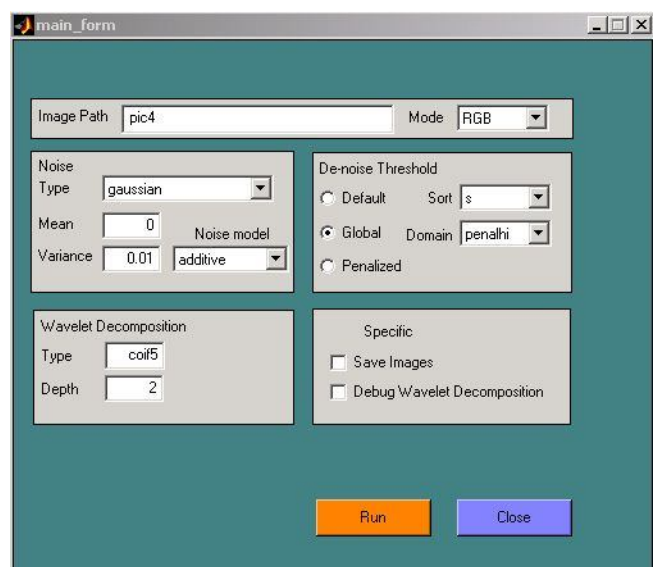


Fig. 1. The GUI for medical images filtering, based on DWT

The area “Image Path” is for entering an image file name, but without an image file extension. For example, if the file name is “pic4.jpg”, the user should write “pic4”. The image file for de-noising must be in the same directory (folder), where the main program and the rest modules are. The image processing is made in two modes – RGB and YUV, chosen through the pop-up menu, default value is RGB. The user can

choice the type of noise, in order to simulate real situation with noised medical images. In Fig.2 are given the default values for different noise type and models.

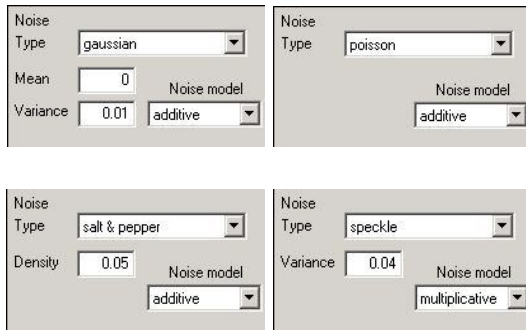


Fig. 2. The area “Noise”

The wavelet decomposition settings are selected in area “Wavelet Decomposition”, shown in Fig.3. Two parameters can be selected: the 2D discrete wavelet function and the depth of decomposition. The decomposition depth must be positive integer. Recommended values for “Depth” are 1 and 2, because bigger values cause more noise components removal, as well as losing more useful parts of the image.



Fig. 3. The area “Wavelet decomposition”

The type of the wavelet function can be selected from many families of functions, depending of the concrete application [6]. The family of the orthogonal wavelet functions is most suitable for this application. It includes the following functions: Daubechies, Symlets and Coiflets.

Selecting appropriate threshold is an important part in de-noising of medical images. Giving the determinate threshold of the level and breaking on level the circumstantially coefficients, can be reduced also the level of the noise. But the most interesting aspect of this problem is that the level of limitation can be determined separately for every one coefficient. This allows making adaptive changes of the signal. The user can select the threshold in the “De-noise threshold” area. There are three types of thresholds – default, global and penalized with parameter alpha, which is a floating value. The threshold is applied to the wavelet coefficients. They become equal to zero if their value is smaller than the selected threshold, and the bigger coefficients are processed according to the threshold’s Sort – soft (‘s’) or high (‘h’). The area “De-noise Threshold” is shown in Fig. 4.



Fig. 4. The area “De-noise threshold”

The area “Specific” gives an opportunity to save results in image files in ‘jpg’ format, if ‘Save Images’ is checked and display information about input data if ‘Debug Wavelet Decomposition’ is checked (Fig. 5).



Fig. 5. The area “Specific”

The images are saved in the folder, where the main program and its modules are. Images have a string, added to their name before the extension: for RGB mode: ‘-nRGB’ is for noised, ‘-dnRGB’ is for denoised; for YUV mode: ‘-nYUV’ is for noised, ‘-dnYUV’ is for de-noised in YUV and ‘-dnYR’ is de-noised in YUV and converted to RGB.

After choosing all input information the procedure of de-noising begins, when the user clicks on button ‘Run’. Then the final result is shown – original image, noised image and de-noised image. When button ‘Close’ is pressed the user is asked whether he wants to quit the program. If he chooses ‘Yes’, the program can be closed, if he chooses ‘No’, he continues working with the program.

In Fig.6 and Fig.7 are shown respectively the visualizations of original and processed MRI image of size 935x670 pixels from gastroenterology. For its noise reduction is used an additive model to Gaussian white noise. The Gaussian noise is typical for this medical modality of images.



Fig. 6. The original MRI image



Fig. 7. The processed MRI image

III. TASKS CARRIED OUT FROM THE MAIN PROGRAM

The basic algorithm that works behind is shown in Fig.8.

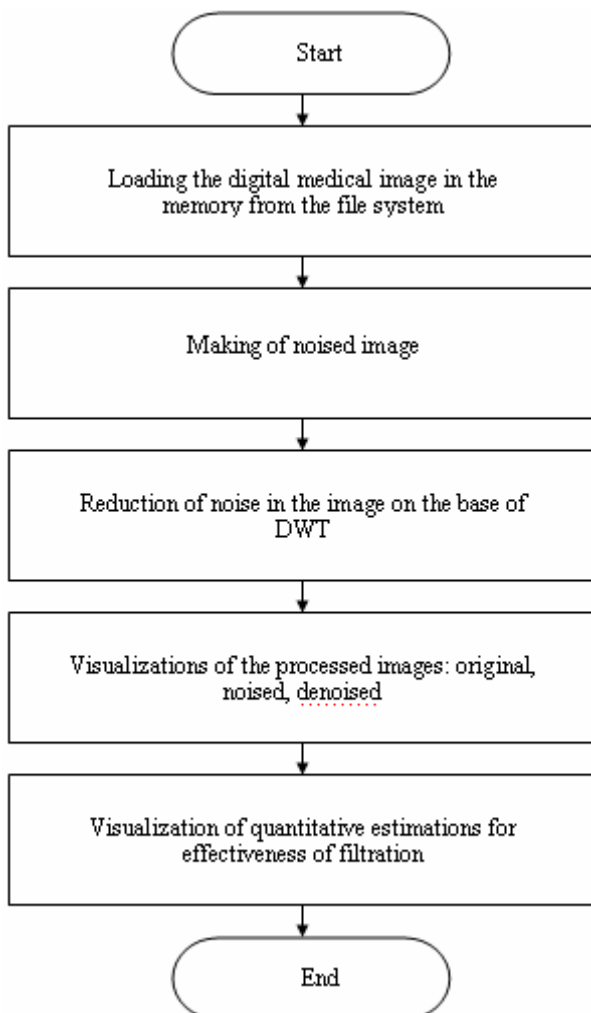


Fig.8. Block diagram of the algorithm

By acting of component from GUI can be implemented a callback-function from the main program. Every graphic component can be treated to object. Every object can be referred to handle. The objects referred a complex of attributes, which can be manipulated from the software. The multifarious attributes can be leaved for using in MATLAB environment, such as “Enabled”, “Value”, “Visible”, “On”, ”Off” etc.. Every attribute can be enabled in the presence of corresponding handle or reference to the object. Every graphic component can be reiterated to a cycle of events for the MATLAB environment by initialization of the graphic application. It submits addresses of the callback –functions, associated to a given event, which are important. By its identification can be called out a corresponding callback-function.

One of the important tasks that the main program has is input data validation. The execution is canceled if an error concerned with wrong information occurs. Another essential purpose of the main program is presenting the input information in appropriate data structures. It is necessary for the next steps in the de-noising strategy, especially in the noise removal with wavelets. In this step the processing is made with appropriate input data. Wrong information prevents wavelet processing from carrying out or may lead to wrong output.

The noise reduction can be realized by using global or penalized thresholds. For determination of the threshold the Birge-Massart strategy is used. This strategy is flexible and determines the threshold in three directions: horizontal, vertical and diagonally. The threshold depends on the wavelet decomposition for the corresponding level, noise variance and a penalizing parameter α [2].

The applied algorithm calculates also some objective quantitative estimation parameters as: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR). On the base of their analysis can be selected the most suitable wavelet function, level of decomposition, type of the threshold and its parameters.

IV. CONCLUSION

In the paper is presented a GUI for noise reduction in medical images. The software processes the images in the DWT domain. It uses MATLAB defined function and works in MATLAB 6.5 environment. The pre-processing can make a nonlinear or adaptive filtration by using best tree decomposition and penalized thresholds. The GUI can be used in engineering education for studying this wavelet application. It can be used also in real time to provide important anatomical information to physicians and specialist upon diagnoses of different diseases can be made.

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